RURAL ENERGY SURVEYS - REVIEW OF METHODOLOGIES AND ISSUES

VEENA JOSHI AND VENKATA RAMANA P.

Paper Presented at the Workshop on
Decentralized Rural Energy Planning and Implementation
Conducted at Nagpur, September 1-2, 1989

TATA ENERGY RESEARCH INSTITUTE, NEW DELHI

AUGUST, 1989

INTRODUCTION

Studies of rural energy use patterns in India began first in the late 1970s. Initially, a few scientists, who strongly advocated appropriate technologies to alleviate the just-perceived rural energy crisis, conducted some energy surveys. As the concern grew into the 80s, governmental organizations like the Department of Non-conventional Energy Sources (DNES), Planning Commission and its Advisory Board on Energy (ABE), and various state energy development agencies commissioned several academic and research institutes to conduct rural energy surveys in different regions of the country; these studies were meant to provide the database for micro-level energy planning. These studies, numbering presently in hundreds, have been made at various levels viz. village, village cluster, block and district. They present a micro view of the rural energy situation in the country in its different regions. In addition, a few macro studies were also conducted which gave an overall picture (NCAER, ITES) for the country as a whole.

The present study looks at more than fifty such micro-level survey reports to review the objectives, methodologies and the data presented in these reports and to present the issues related to biomass energy sources that arise out of the analysis. Though it has not been possible to review all the micro-level studies, we feel that the points raised in this paper are relevant to all such studies in future. However, to obtain a complete overview of the methodological issues, this study needs to be extended to cover commercial and renewable energy sources.

ANALYSIS OF SURVEYS

In the fifty-odd survey reports analysed in this study, nearly half were sponsored by DNES and ABE, and the rest done by others. After presenting a profile of the areas surveyed in these studies, we have examined the coverage of various studies, the different methodologies adopted to select villages and households, and to collect information. This is followed by an assessment of the extent of information available in different studies on energy consumption and supply. The issues related to its use in the planning process are discussed.

Profiles of Energy Surveys

The total number of villages covered by these surveys was 750. As for the state-wise distribution of the surveys, Uttar Pradesh and Rajasthan together account for nearly two-thirds of the villages (Table 1). However, maximum number of individual surveys were conducted in Andhra Pradesh (19) followed by Uttar Pradesh (11). Silora block of Rajasthan has the distinction of being the area in which maximum number of villages (110) were covered in a single study. While most studies did not specify the particular agroclimatic region they were conducted in, all the nine studies sponsored by the ABE were done in specific agroclimatic regions.

In studying the energy use in rural areas, environmental description of the region being studied is very important as factors like demographic details, socio-economic pattern and, more importantly, land use pattern greatly affect the supply of biomass and other fuels and consequently the consumption pattern.

owever, eight of the 57 studies reviewed were found to contain o environmental description of any kind (Table 2). Another leven studies considered demographic factors and land use attern but not socio-economic indicators. Eight studies emained content with furnishing only demographic details. Thus, nly 25 studies considered all the three factors.

However, even though different studies have collected data n various environmental factors, few of them have actually shown he linkages between these factors and the energy use. Even in he studies which described the land use pattern, many confined hemselves just to the cropping pattern on the agricultural land mitting information on forest land, fallow land, grazing land, .c. In the instances where forest land was given, ategorization of the forest was missing (reserved forest, civil orest, etc.) which determines the accessibility of fuel and odder to the people.

In the single village surveys, exchange of fuels with the ighbouring villages or market is mostly not considered. In ea-based studies, the system boundaries are still kept as llage boundaries and area is treated as an aggregation of llages. Here a methodology to examine the relations within an ea and relations of the area with the rest of the system needs be developed.

Table 1: Distribution of the Village Studies

State	No. of Studies	No. of Villages
Andhra Pradesh	19	75
Bihar	2	34
Gujarat	3	75
Haryana	4	13
Karnataka	6	7
Kerala	1	50
Madhya Pradesh	1	1
Maharashtra	5	82
Orissa	1	4
Punjab	3	4
Rajasthan	2	118
Uttar Pradesh	11	287
Total	58	750

Table 2: Environmental Description*

Category	Number	Percentage
Studies with		
No environmental description	8	14
Environmental description	25	45
Only demographic indicators	8	14
Only socio-economic indicators	1	2
Demographic & socio-economic indicators	4	6
Demography and land use pattern	11	19
Total	57	100

* Three factors considered are: 1)demographic 2) socio-economi
3) land use pattern

Objectives

Initially the surveys had the single objective of finding out the energy consumption pattern (fuel-end use matrix). However, the later studies, especially the ones sponsored by DNES and ABE had multiple objectives as they were meant to be used as tools in the planning for energy development in the future. For them, establishing the energy consumption pattern was a starting point. A typical study of this kind has some or all of the following objectives:

a) To assess the energy use pattern in different sectors of rural economy at a micro level;

b) To assess the availability of local biomass resources;

c) To project energy demand at decentralized level; and,

d) To propose decentralized and integrated energy development plans.

Nearly 65 per cent of the studies had multiple objectives while only 19 studies had a solitary objective. The pattern of surveys shows that information on environmental factors is lacking in the surveys not having multiple objectives. However, there are also a few studies with multiple objectives but little data. But, on account of the fact that they needed to not only study the use pattern but also project the future demand as well as suggest technologies to meet the demand, surveys with multiple objectives have perforce collected more information.

Methodology of Surveys

The measure of success achieved in meeting the above mentioned objectives depends on

- the method of selection of villages,

- the method of selection of sample to be studied,
- the identification of data/information items, and,
- the method of data/information collection.

Though there are possibilities of very diverse methods, very little discussion is found in the published literature on these possibilities as well as on the appropriateness of various methods for achieving different objectives.

Most of the studies surveyed do not mention the process of selection of villages or the criteria of selection. In almost all studies, household has been identified as the source of information. While some of the studies used random sampling, some others have considered various factors like economic status, physical location, landholding category, etc., in deciding the sample. The 57 surveys covered over 30000 households in 750 villages at an average of 40 per village. However, the sample size varied from survey to survey ranging from six households in four villages to 1359 in 10 villages. But all the single village studies invariably covered the entire population instead of choosing a sample. In a few studies, commercial establishments are considered but markets are seldom surveyed. Very few studies have considered time budget studies, studies related to the use of common land, energy system studies or the dynamics of local institutions.

The most common method of data collection, irrespective of objectives of the study, magnitude and study region, is through questionnaire. While some surveys used separate questionnaires to get information on village level data, socio-economic conditions, fuel consumption, etc., most used a single combined questionnaire. Out of the 57 surveys, 40 depended on the questionnaire for collecting information. Another five surveys used the method of personal interviews without any structured questionnaires.

However, 8 of these surveys conducted actual measurements of the fuels being consumed at the time of cooking to accompany the data collected through recall. And another two surveys relied primarily on actual measurements. It is known that the method of recall runs the risk of obtaining unreliable data as it depends on the ability of the respondant to recall information which can only be done with doubtful accuracy.

Energy Consumption

The specific objectives of a village level study to examine energy consumption pattern can be -

a) to identify different end uses, and fuels used in the village to build a fuel-end use matrix of energy consumption;

b) to measure/estimate end use efficiencies to arrive at energy consumption norms for different end uses; and,

c) to identify parameters that affect the pattern and level of energy consumption.

Such information is of use, to build macro-level database to estimate energy demand and to monitor the impact of interventions in the rural economy. However, we have observed that only a small part of it feeds into the decentralized planning exercise. In the studies we examined, the data on energy consumption is very varied across the surveys. For instance, only 13 studies collected data on all the primary sectors of the rural economy, viz. domestic, agriculture, industry/business and transport. Most surveys confined themselves to just either domestic (11) or domestic and agriculture together (12).

Table 3: Extent of Data on Energy Consumption in Different Sectors

Category	Number	Percentage
Surveys studying		
All sectors (Domestic, agriculture, industry, tranposrt)	13	23
Three sectors (Domestic, agriculture, industry)	9	17
Three sectors (Domestic, agriculture, transport)	5	9
Two sectors (Domestic, agriculture)	12	22
Two sectors (Domestic, industry)	3	5
One sector (Domestic)	11	20
One sector (Agriculture)	2	4
Total	56	100

But even in the surveys which covered all sectors, the identification of end uses is not same. For instance, out of 34 surveys which covered the agricultural sector, as many as 25 gave only the aggregate energy consumption figures for agriculture (crop-wise) but not according to end uses like irrigation, land preparation, threshing, fertiliser, etc. Though most studies identified end uses in the domestic sector like cooking, lighting and water heating, five studies gave only aggregate energy use. One study however, apart from other end uses, gave energy consumption figures for cattle feed preparation as a separate end use. Six studies gave aggregate figures for industry and seven for transport. Interestingly, six studies have not mentioned any end uses at all.

Among the fuels considered, firewood, cropwastes, dung, kerosene, electricity and diesel were common in most studies. Only 12 out of 54 studies reporting firewood quantities gave separate figures for logs and twigs and just one study reported the use of wood shavings. Some surveys, however, also looked at other fuels like charcoal, sawdust, dry grass, etc. For agriculture, animate energy was given mostly in man-hours and animal-hours. For transport, number of vehicles in the village were given in some surveys. In some cases, transport energy was combined with agriculture as most of it was only agricultural transport.

Though there has been some discussion, there seems to be no agreement over how data should be presented. Original units, energy units, useful energy units, day, month, season, year, per capita, per household, per acre have been used according to the study teams' preference. Also very little attention is paid to analyse the accuracy of information/data gathered.

The variations in the level and pattern of energy consumption in various sectors depend on many parameters like household income, landholding, cattleholding and family size. Also, there are two environmental factors that influence the use pattern, season and altitude. No study under review has considered all these factors but only some of them (Table 4a). Out of 56 surveys, only two studied the effect of three parameters and another two studies, four parameters. Nearly one third of them did not study any parameter at all, while 24 surveys studied just one parameter (Table 4b). 12 of these have landholding size as the parameter. The rest were accounted for by income group in four studies and seasonal variation in the rest. One study recorded variation in fuel consumption by the amount of monthly expenditure. 16 studies, however, considered seasonal variation.

Interestingly, even though cattleholding pattern would have given an idea of the access to dung which has an effect on the fuel-mix, most of the studies have not looked at the variations by the cattleholding household groups. Likewise, though family size infleunces the quantity of fuels consumed, just six surveys looked into the variation caused by family size. Fuel consumption variation by altitude was considered in just one study.

Table 4a: Influencing Parameters

Parameters considered	No. of Studies
Income	12
Landholding	24
Cattle	0
Family size	6
Season	16
Altitude	1

Table 4b: Number of Parameters

No. of Studies	No. of Parameters Considered
18	0
24	1
10	2
2	3
2	4

Efficiency of the energy devices is another determinant in the energy consumption. However, only 20 out of 57 studies looked at the devices being used for various end uses. But the reference was normally a sketchy description of devices with almost no data on their efficiency, use pattern, etc.

Incomplete coverage of fuels, end uses, sectors and variations in energy consumption apart, almost all surveys were "one-time" studies conducted at a particular point of time or period. It is very difficult to get an idea of the changing trends in the consumption pattern with this "one-time" data. For instance, very little is known about the fuel substitution, that is, which fuel is replacing which over time and why.

Despite all the limitations, a study to analyze these micro-level surveys to supplement the existing macro-level database will be very valuable. Also, since it is observed that the consumption data is sparsely used in the decentralized planning exercise, such extensive surveys need not always be part of a micro-level planning exercise.

Energy Supply

It is known that the biomass resources have energy as well as non-energy uses. Hence, a study to assess energy supply situation should examine for each type of biomass

a) its availability pattern;

b) pattern of its use for energy and non-energy purposes; and,

c) identification of major influencing parameters.

Thus, instead of a consumption oriented survey, one can conduct a survey for the purpose of assessment of resource availability as a prerequisite for planning exercise. This is not to say that consumption patterns are not needed, but to emphasize on assessment of biomass resources and their availability after incorporating energy and non-energy uses.

Assessment of the energy supply resources is perhaps the biggest weakness of rural energy surveys. This weakness has been caused, more than anything else, by the difficulty involved in estimating the biomass resources and their energy and non-energy use. Thus, this is one area scarcely touched upon by most surveys. Not surprisingly, only 14 out of 51 studies attempted to assess the supply sources but mananged to cover them only in a perfunctory manner. Moreover, whatever estimates that were done, were from the consumption side rather than resource side. For instance, the quantities of biomass consumed were taken as the available supply in many studies. Clearly there is a need to develop methodologies to assess the biomass resources, to assess the extent of their use in different activities and to estimate losses in collection, preparation, etc.

Development of a Decentralized and Integrated Energy Plan

Typically, development of a decentralized and integrated energy plan involves

a) assessment of energy demand for different activities and their prioritisation;

b) evaluation of options (techno-economic, socio-cultural); and,

c) development of a management strategy to implement the plan.

The assessment of energy demand for different end uses requires an understanding of the present consumption, perceived needs and the extent of scarcity. Some studies have used consumption data, and made demand projections based on population increase and expected increases in the levels of consumption. Very few studies have incorporated the perception of the people in prioritising their energy demand. Fewer still have examined the indicators of fuel scarcity.

Increases in time for fuel foraging, travelling distance, number of family members, etc., are some of the indicators that can be used to understand the fuel scarcity. Changing proportion of the fuels collected and purchased also indicates the scarcity of biomass fuels. Thus, good description of the environmental factors is absolutely essential in assessing the fuel scarcity. Even though few surveys under review collected data on the scarcity indicators, more than half of them gave the percentage of fuels being purchased and collected. However, some studies, aiming mainly at exposing the drudgery of women in collecting fuel, gathered statistical evidence for some of the scarcity indicators.

As discussed in the earlier section, the assessment of available biomass resources needs development of methodological framework. However, to plan for the use of these and additional biomass resources would necessitate an understanding of the factors that influence the cattle population, cropping pattern, and the use of woody biomass. These, we find are seldom considered in depth.

Having assessed demand and supply, it is possible to examine the suitability of various options which could be related to enhancement of biomass resources, introduction of technologies based on non-conventional energy sources or improving the efficiencies of use. Very few studies have recommended technologies that are not readily available today. These studies, however, point out for a need to orient the technology development efforts to meet such specific demands. Our ability to respond to these local needs and to mobilise the involvment of local manpower will determine the success of these micro-level energy planning in the long run. This may call for stronger linkages with the other sectors of the rural economy.

PRINCIPAL OBSERVATIONS

a) There is no uniformity in the analysis and presentation of consumption related data across the studies; also very few studies discuss the variation in the data. Most studies have not attempted to project energy demand or to identify the socio-economic parameters that affect the demand. Very little of the consumption related analysis is utilized in formulating an energy development plan. However, we feel that a study to examine this data should be undertaken to arrive at consumption norms for different end uses in different agro-climatic regions to enrich the existing macro-level database (NCAER, ICAR studies) on rural energy situation in the country. Such an exercise will also enable us to identify the gaps in the existing methodology. We suggest that in future, the data on the rural energy consumption pattern may be gathered as a part of national/state level efforts to generate statistical data to ensure consistency in the methodology. In case of decentralized integrated energy planning exercises, wherever necessary, the regional consumption norms can then be taken as the guideline.

b) The present methods of assessment of local biomass resources do not give a complete picture of the availability of these resources. There is a need for developing a common methodological framework for biomass assessment. Here, we suggest that the surveys primarily aimed at formulating energy development plans can be carried out, start with the assessment of various biomass resources and then estimate their use for energy as well as non-energy activities. One can thus develop local material balance equations for biomass resources. The changes in these balances, due to socio-economic and cultural factors will eventually dictate the availability of these resources for energy development activities.

c) We feel that our present approach to decentralized village level planning in many cases has been rather static in choosing among the technological options existing at present. This has often led to obvious recommendations like promotion of improved chulhas and biogas plants. While the proposals for rural energy development plans can incorporate the results of pre-dissemination surveys for the ongoing programmes (no of improved chulhas, biogas plants, demonstration of other devices) as the first phase of energy development activities, they should concentrate more on identifying and developing specific schemes with detailed feasibility studies to meet the local energy needs and to improve local situation. Development of such proposals for rural energy development will require a multi-disciplinary approach and implementation of these plans will need technology/device development centres in different regional institutes.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. Gururaja for initiating this study, Mr. Ajit Gupta and his colleagues at DNES, and Dr. E.A.S. Sharma of the Planning Commission for making the survey reports available for this study.

BIBLIOGRAPHY

1. Kumar, M.C., et al., Energy Consumption Pattern in Villages, B.E. Thesis, Submitted to Department of Mechanical Engineering, Siddhaganga Institute of Technology, Tumkur, 1978.

2. Energy Use in Pura Village, India, Soft Energy Notes, July 1979.

3. Gupta, C.L., K. Usha Rao and V.A. Vasudevaraju, Domestic Energy Consumption in India (Pondicherry Region), Energy 5, 1980. pp. 1213-1222.

4. Reddy, A.K.N. and D.K. Subramanian, The Design of Rural Energy Centres; Rural Technology, Indian Academy of Sciences, Bangalore, 1980, pp. 109-130.

5. Pachauri, R.K. and P. Govind Rao, Study on Energy Plans and Flows in Five Typical Villages of Andhra Pradesh, ASCI, Hyderabad, 1981.

6. Rural Energy Consumption in Southern India, Institute for Techno-Economic Studies, Madras, 1981.

7. National Council for Applied Economic Research Report on Rural Energy Consumption in Northern India, Environment Research Committee, Department of Science and Technology, GOI, 1981.

8. Ravindranath, N.H., et al., Indian Village Agricultural Ecosytem - Case Study of Ungra Village, Part I: Main Observations; Biomass, 1(1), 61-76, 1981.

9. Reddy, A.K.N., Indian Village Agricultural Ecosystem - Case Study of Ungra Village, Part II: Discussion; Biomass, 1(1), 77-88, 1981.

10. Malhotra, K.S. and P.B.L. Chaurasia, A Plan for Energy Management in 110 Villages of the Silora Block in Rajasthan, Energy, 1981, 6, pp. 591-601.

11. Gupta, R.R., et al., Biomass Energy Consumption in Rural Households; Urja, 12(1), 15-17, 1982.

12. Reddy, A.K.N., Rural Energy Consumption Patterns - A Field Study; Biomass 2(4), 255-280, 1982.

13. Swaminathan, Madura. A Study on Energy Use Patterns in Garhwal Himalaya, Paper presented at the Technical Seminar on Women's Work and Employment, Institute of Social Studies Trust, New Delhi, April 1982.

14. Evaluation of Fuelwood Supply and Need in Asian Countries, FAO Regional Study, Undated.

15. Subramanian, D.K. and K. Mallikarjuna Chetty, Domestic Cooking and Lighting Energy Needs and Devices for Rural Areas: Some Optimal Scenarios; Seminar on Rural Energy Future - Perspective for Policy Alternatives, Bangalore, Nov. 24-26, 1983.

16. Subramanian, D.K., Energy Utilization and Optimal Energy Models for End Use in Rural Areas; Seminar on Rural Energy Futures - Perspectives for Policy Alternatives, Bangalore, November 24-26, 1983.

17. Swaminathan, K.R., et al., Energy Requirements for Household Activities Performed by Farm Women; Seminar on Rural Energy Futures - Perspectives for Policy Alternatives, Bangalore, November 24-26, 1983.

18. Mishra, B.K. et al., Studies on Village Ecosystems of North Canara District of Karnataka, Technical Report 12, Centre for Ecological Studies, Indian Institute of Science, Bangalore, 1983.

19. Bowonder, B., et al., Energy Use in Rural Areas and Biomass Energy Management; Proceedings of the Regional Workshop on Biomass Energy Management, Administrative Staff College of India, Hyderabad, December 27-29, 1983, 2.1-2.20.

20. Siddharta Bhatt, M., Industrial and Domestic Energy Consumption in Nellore Villages; Sadhana, 7, Pt. 4, 315-328, 1984.

21. Sharan, G., Cooking Fuels in Rural North Gujarat; Energy Management, 8(3), 209-215, 1984.

22. Bowonder, B., et al., Energy Consumption in Rural Areas of Semi Arid Agro Climatic Regions, Centre for Energy, Environment and Technology, Administrative Staff College of India, Hyderabad, 1984.

23. Maheshwari, R.C., et al., Summary and Conclusions of the Report on Energy Census and Resource Assessment of Village Islamnagar in the District of Bhopal; Proceedings: Summer Institute of Energy Management and Rural Sector, CIAE, Bhopal, June 5-28, 1984 (Tech. Bulletin No. CIAE/81/28).

24. Desai, V. Ashok, Ends and Means in Rural Energy Surveys, Manuscript Report-IDRC-MR112e, International Development Research Centre, Ottawa, 1985.

25. Moench, Marcus. Resource and Utilization and Degradation - An Integrated Analysis of Biomass Utilization Patterns in a Garhwal Hill Village, Northern Uttar Pradesh, India, Masters Thesis, University of California, Berkeley, 1985.

26. Natarajan, I., Domestic Fuel Survey with Special Reference to Kerosene (Vol. I & II), NCAER, New Delhi, 1985.

27. Kumar, Sampath T., et al., Pattern of Non-commercial Energy Consumption and Availability in the Indian Domestic Sector: A Case Study; Agricultural Wastes, 12(1), 55-60, 1985.

28. Chandola, L.P., et al., Pilot Survey of Fuel Consumption in Rural Areas III: Village Karaundi Resurveyed; Indian Forester, 111(4), 208-14, 1985.

29. Athavale, M.C. and K.S. Yadav, Estimation of Energy Requirements of a Village, Seminar on Rural Energy: Problem of Crisis, Bangalore, Jan 23-24, 1985, Ip.

30. Rao, Hemlata, Energy Consumption Pattern in a Backward Village; Proceedings of Seminar on ¢Rural Energy: Problem of Crisis, Institute for Social and Economic Change, Bangalore, Jan. 23-24, 1985 .

31. Sagar, S.R., et al., Pilot Survey of Fuel Consumption in Rural Areas IV; Indian Forester, 111(5), 305-17, 1985.

32. Rao, K.S., et al., A Rural Energy Survey in 50 Villages of Gujarat State, India; Ninth Biennial Congress of the International Solar Energy Society, Montreal, 23-29 June, 1985, Vol. 4, p. 2570-2576.

33. Moulik, T.K., P.R. Shukla and S.K. Sinha, Optimal Selection from Centralized and Decentralized Energy Generating Technologies for Meeting Rural Energy Needs, Indian Institute of Management, Ahmedabad, 1985.

34. Somasekhara, N., Rural Energy, 1986.

35. Bowonder, B., et al., Energy Use in Rural Areas: A Study of Ten Villages in India; Natural Resources Forum, 10(4): 389-397, 1986.

36. Dahiya, A.K. and P. Vasudevan, Field Study of Energy Consumption Pattern of Small Farms; Energy, 11(7), 685-689, 1986.

37. Sharma, Rishi and Ramesh Bhatia, India: Meeting Basic Energy Needs of the Poor, UNDP-ESCAP-ILO, 1986.

38. Ramasastry, A., et al., Energy Use in Semi-Arid Tropics of India, ASCI, Hyderabad, 1987.

39. Bose, Ranjan et al. A Plan for Renewable Energy Development in a Village of Uttar Pradesh - Village Maulaganj, Tata Energy Research Institute, New Delhi, 1987.

40. Joshi, Veena, et al., Renewable Energy Potential and the Development in a Tribal Village of Uttar Pradesh, Tata Energy Research Institute, New Delhi, 1987.

41. Puri, Charu et al., A Plan for Renewable Energy Development in a Village of Uttar Pradesh - Village Arro, Tata Energy Research Institute, New Delhi, 1987.

42. Girija Sharan (ed), Energy Use in Rural Gujarat, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

43. Rural Energy Survey and Integrated Energy Plan for Sankheda Taluka, Operations Research Group, Baroda, 1987.

44. Alam and Hussain, Energy Scenario in the State of Jammu & Kashmir, Vinod Kumar and Dilip R. Ahuja (ed), Rural Energy Planning for the Indian Himalaya, Wiley Eastern, New Delhi, 1987.

45. Pant, D.D. and S.P. Singh, Energy-use Patterns and Environment Conservation: The Central Himalayan Case, Vinod Kumar and Dilip R. Ahuja (ed), Rural Energy Planning for the Indian Himalaya, Wiley Eastern, New Delhi, 1987.

46. Mathur, T., Status Paper: North Eastern Region, Vinod Kumar and Dilip R. Ahuja (ed), Rural Energy Planning for the Indian Himalaya, Wiley Eastern, New Delhi, 1987.

47. Ramakrishnan, P.S., Energy Flows and Shifting Cultivation, Vinod Kumar and Dilip R. Ahuja (ed), Rural Energy Planning for the Indian Himalaya, Wiley Eastern, New Delhi, 1987.

48. Bartwal, P.S., Fuelwood Consumption Pattern in Rural Areas - A Case Study; *Journal of Tropical Forestry*, 3(2), 136-141, 1987.

49. Bose, R.K., Renewable Energy Potential and Its Consumption in Village Berka Alimuddin of Haryana, TERI Discussion Paper No. 4/87, Tata Energy Research Institute, New Delhi, 1987.

50. Puri, Charu, Analysis of Energy Consumption and Production Pattern in Dhanawas: A Survey Report, Discussion paper No. 2/88, Tata Energy Research Institute, New Delhi, 1988.

51. Singh, S., et al., Energy Use Patterns Under Various Farming Systems in Punjab; *Applied Energy*, 30(4), 261-268, 1988.

52. Integrated Rural Planning Surveys for Soreng Block, West Sikkim, Development Alternatives, 1988.

DNES SPONSORED STUDIES

1. Department of Non-conventional Energy Sources, Schedule for Rural Energy Systems, DNES, Delhi, 1984.
2. Foundation to Aid Industrial Recovery, Integrated Rural Energy Centre - Thukkuguda, Andhra Pradesh, 1984.
3. Eco-community at Kancharpalayam, Satyavedu taluk, Chittoor, Andhra Pradesh, Tata Energy Research Institute, Pondicherry, 1984.
4. Integrated Energy Systems Project - Guddimallan Village, Chitoor district, Andhra Pradesh, Tata Energy Research Institute, Pondicherry, 1984.
5. Krishnaji, Report of the Project Planning Integrated Energy Systems for Rural Clusters in Eastern U.P. - Phase I, The National Academy of Sciences, Allahabad, 1984.
6. Technical Teachers Training Institute, Project Report on Integrated Rural Energy Centre of Total Village Development Project - Village Pandori, TTTI, Chandigarh, 1986.
7. Vidyanath, Sources and Pattern of Energy Consumption in Type Villages in Andhra Pradesh, 1986.
8. Converting Community Biogas Plants into Integrated Rural Energy Centres, Renewable Energy Division, Punjab Agro Industries Corporation, Chandigarh, 1986.
9. Krishnaji and S.S. Bhatnagar, Report of the Project Planning Integrated Energy Systems for Rural Clusters in Eastern U.P. - Phase II, The National Academy of Sciences, Allahabad, 1986.
10. Seshadri, C.V. and V. Hoon, Case Study to Investigate the Patterns of Energy Consumption and Requirements of Shepherd Communities in Kumaon Himalayas, Photosynthesis and Energy Division, Murugappa Chettiar Research Centre, Madras, 1986.
11. National Productivity Council, Project Rural Renewable Energy System on Gollahati, HO/Agali, Madacasira Taluka, Anantpur district, Hyderabad, 1986.
12. National Productivity Council, Project Rural Renewable Energy Systems on Chimakolumapalle, H/O of Govardhangir, Kurnool district, Hyderabad, 1986.
13. Rural Renewable Energy Scheme for Kothasathram village in Andhra Pradesh, Non-conventional Energy Development Corporation of A.P. Ltd., , Hyderabad, 1986.

14. Rural Renewable Energy Scheme for Thimmapuram village in Andhra Pradesh, Non-conventional Energy Development Corporation of A.P. Ltd., Hyderabad, 1986.

15. Rural Renewable Energy Scheme for Venadu village in Andhra Pradesh, Non-conventional Energy Development Corporation of A.P. Ltd., Hyderabad, 1986.

16. Rural Renewable Energy Scheme for Gollapally village in Andhra Pradesh, Non-conventional Energy Development Corporation of A.P. Ltd., Hyderabad, 1986.

17. Rural Renewable Energy Scheme for Madhavapally village in Andhra Pradesh, Non-conventional Energy Development Corporation of A.P. Ltd., , Hyderabad, 1986.

18. Survey Report on Integrated Energy Planning of Selected Villages in Ahmednagar District, Maharashtra, Pravara Institute of Research and Education in Natural and Social Sciences, Loni, 1987.

19. A Survey Report on Nineteen Villages Selected for Urjagram Programme in Singhbhum district, Bihar, Development Alternatives, New Delhi, Undated.

20. S.S. Bhatnagar, Report on the Project Survey of the Pattern of Energy Consumption in 50 villages of 10 districts of Western U.P., National Academy of Sciences, Allahabad, 1988.

21. Decentralized Energy Planning of Selected Villages and Preparation of Energy Plan in Wardha District - Village Reports 1 to 50, Operations Research Group, Baroda, 1988.

ABE SPONSORED STUDIES

1. Brahme, Sulabh and Paranjpay, Case Study of Marathwada Region, Maharashtra, Gokhale Institute of Politics and Economics, Pune, 1985.

2. Sankar, T.L. and Usha Rao, Rural Energy Consumption Survey in Godavari Delta Region, Institute of Public Enterprises, Hyderabad, 1985.

3. Rural Energy Generation and Use Pattern - Southern Kerala, State Planning Board, Trivandrum, 1985.

4. Study on Energy Use in Rural Area of Uttarakhand (U.P.), Giri Institute of Development Studies, Lucknow, Undated.

5. Singh, Bhanwar, Energy Use Patterns in Rural Orissa, Centre for Social and Technological Change, Bombay, 1987.

6. Rao, Hemalata, et al., Rural Energy Consumption Pattern in Karnataka, Institute of Social and Economic Change, Bangalore, 1987.

7. Ghosh, P.P. and Sudhir Kumar, Rural Energy Consumption Patterns in Plateau Region of Bihar, A.N. Sinha Institute of Social Studies, Patna, 1987.

8. Ahuja, Kanta and M. Rathore, Rural Energy Consumption Pattern - A Study of North East Rajasthan, Institute of Development Studies, Jaipur, 1987.

9. Bhatanagar, A.P. and B.S. Paneswar, Energy Flows and Their Socio-economic Implications in the Rural Sector of Northern India, School of Energy Studies, Punjab Agricultural University, Lucknow, 1988.

[illegible] Energy Research Institute
Library
[illegible] Delhi
1457/aR